CH 1786 REVM

Cermetek
Microelectronics Inc.

CH1786 Family - 2400bps Modem Ultra Small Module

HITEK A DIRECT (416) 706-7616

A/N. 110 114

Now U.L. 1459 Approved

INTRODUCTION

The CH1786 is the smallest, full function 2400bps modem that is FCC Part 68 approved. It offers a fast and easy way to integrate a modem into an OEM product while utilizing a minimum amount of PCB space (1" x 1.25" x 0.52). The CH1786 has two interfaces, a CCITT V.24 serial interface that can be routed directly to a UART, and a Tip and Ring signal which goes directly to an RJ11 jack for the telephone line connection. This unit can be controlled with industry standard AT commands and is hence compatible with available industry communication software.

The CH1786 supports asynchronous operations at 2400bps 1200bps and 300bps to Bell and CCITT standards. The resident telephone line interface, or Data Access Arrangement (DAA), while being FCC approved, is also Canadian DOC approvable and can be approved in other countries that require 1000 VAC isolation.

The CH1786 operates off a single 5 volt supply. The low power operation and automatic standby mode make the unit ideal for portable equipment. In addition, its small physical size allows flexibility of equipment design.

GENERAL DESCRIPTION

Figure 1 is a functional block drawing of the CH1786. The CH1786 is a highly integrated, full function modem, comprised of a modulator/demodulator, controller, and an FCC Part 68 approved telephone interface, also called a Data Access Arrangement (DAA).

Modulation/Demodulation and Control

This Functional Block is comprised of a monolithic modem integrated circuit, with built-in facilities to accommodate integrated "AT" command control and resident interfaces for general communication and routing to the DAA.

DAA

The CH1786 is designed to meet North American telephone standards as set by FCC Part 68 and DOC. The telephone line interface is designed to meet 1000 VAC and 1500 volt peak surge isolation, among other parameters. As such it will meet U.S. and Canadian requirements and other international requirements that specify that level of isolation. Cermetek manufactures other modules that meet more stringent international requirements. The CH1786 comes with FCC Part 68 approval, a label is provided with the registration number and ringer equivalent. This label should be prominently displayed. As with most countries, except the U.S. Canada requires submission of the product containing the CH1786 for DOC approval. This can be done by submitting the design to a test house or consultant. Call Cermetek for assistance,

FEATURES

- Supports Standards CCITT V.22bis, V.22, Bell 212, and Bell 103
- FCC Part 68 approved and DOC approvable
- AT Command structure - with extensions
- 1000 VAC isolation barrier
- Single 5 volt operation
- Low power operation with automatic reduced power standby mode
- Automatic adaptive and fixed compromise equalization
- Test modes and diagnostics
- Size: 1.0" x 1.25" x 0.53"
- NVRAM allows storage of custom configurations and telephone numbers
- CH1786 Family includes:

CH1786	2400bps Modem, Non-volatile RAM, Operating Temperature: -20 to +70°C
CH1786ET	2400bps Modem, Non-volatile RAM, Operating Temperature: -40 to +85°C
CH1786LC	Low cost 2400bps Modem, No Non-volatile RAM, Operating Temperature: 0 to +55°C
CH1786FX	Same as CH1786, with Send and Receive Fax

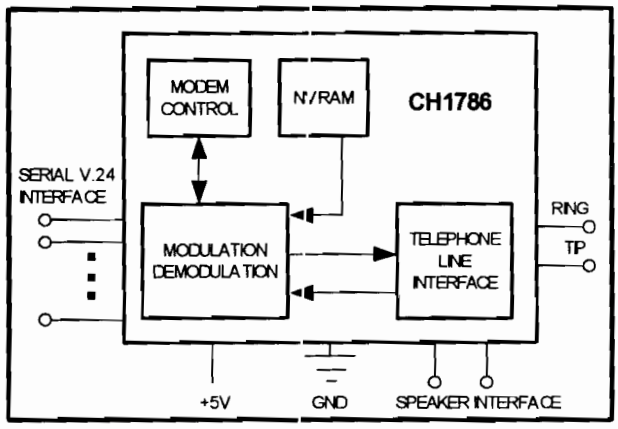

FIG. 1

Supported Features

"AT" Command Set

A 40 character command line is supported. The command line starts with AT and may contain standard or enhanced command The commands are compatible with EIA document TR302.2/88-08006.

Serial Host Interface

The serial interface is V.24 (EIA-232-D) compatible interface. See pin description.

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Speaker Interface

The SPK output reflects the receiver analog input and provides a signal that can be used to monitor call progress. The SPK signal can drive a 300Ω load directly. The SPK signal is usually input to an audio power amplifier and the amplifier drives a speaker coil. Figure 5 shows how to drive an 8Ω speaker.

The speaker can be turned on and off with the ATMn command. The speaker volume can be adjusted by the ATLn command where n is 0, 1, 2, or 3.

Phone Control

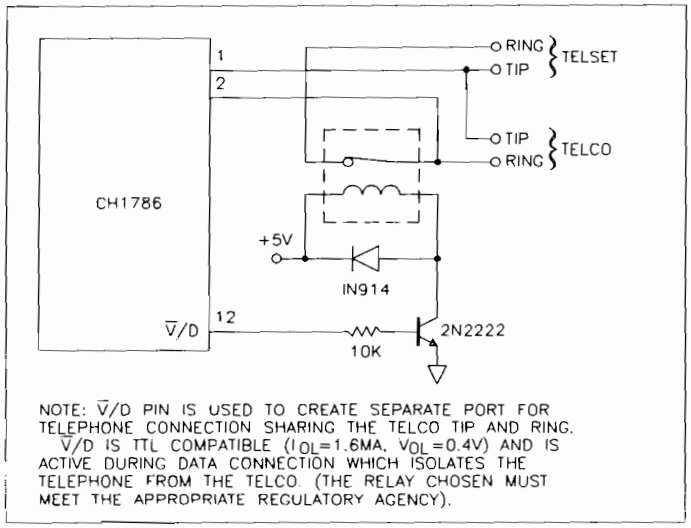
The CH1786 contains a pin called Voice/Data ($\overline{V/D}$). This pin toggles high when the modem goes off hook. This pin can be used to activate a relay which can switch a telephone on or off the Tip and Ring Telco lines. This allows the telephone to be disconnected when a data call is in progress, preventing the data from being disturbed by an inadvertent telephone pick-up. See Figure 2.

Sleep Mode

To minimize the modem power consumption, the CH1786 includes a power down feature called the Sleep Mode. The CH1786 will automatically enter the Sleep Mode after 0 to 255 seconds of inactivity. The time of inactivity is selected by the ATS32 command and 5 seconds is the default time. The modem returns to normal operation when a ring signal is received or upon a input low signal on TXD. ATS24 = 255 disables the Sleep Mode.

A $\overline{SLEEP}$ output signal is available control power to external devices. In Figure 5, a FET controlled by the SLEEP signal turns off the external speaker amplifier when the modem enters the Sleep Mode.

If an application calls for zero power during standby periods, special feature can be added such that when an incoming call is required to wake up the CH1786, the power is switched off and reapplied when RI is active. The CH1786 can be special ordered to support this feature by adding a "P" suffix to the part number e.g. CH1786P, CH1786LCP. The normal operating power will go up by 10% maximum. While in the sleep mode, power will increase to 20 mA. Minimum order for this special part is 100 pieces per release.



NOTE: $\overline{V/D}$ PIN IS USED TO CREATE SEPARATE PORT FOR TELEPHONE CONNECTION SHARING THE TELCO TIP AND RING. $\overline{V/D}$ IS TTL COMPATIBLE (I_{OL}=1.6MA, V_{OL}=0.4V) AND IS ACTIVE DURING DATA CONNECTION WHICH ISOLATES THE TELEPHONE FROM THE TELCO. (THE RELAY CHOSEN MUST MEET THE APPROPRIATE REGULATORY AGENCY).

Figure 2 Voice/Data Port Control.

GUARD TONE

A guard tone of 550 Hz or 1800Hz can be generated at 6 dB or 9 dB below the transmit level, respectively.

ANSWER TONE

A CCITT (2100 Hz) or Bell (2225 Hz) answer tone is generated depending on the selected configuration.

Data Encoding

The data encoding conforms to CCITT Recommendations V22 bis or V.22, or to Bell 212A, or 103, depending on the selected configuration.

Line Equalization

Transmitter and receiver digital filters compensate for delay and amplitude distortion during operation on nominal phone lines. In addition, automatic adaptive equalization in the receiver minimizes the effects of intersymbol interference.

Transmission Speed

The transmission rate of the host computer must be 300, 1200, or 2400 bps. The modem will connect at the selected speed or will fallback to the speed set by the remote modem with the serial interface, the DTE transmission speed is speed sensed. That determines the originate speed.

When the modem answers a call, it determines the transmission speed from the carrier signal of the originating modem. The answering modem matches the originate speed. The answering DTE must match this speed.

Speed and Parity Selection

Before a call, the modem adjusts to the host speed (2400, 1200, or 300 bps) and parity (odd, even, mark, space, or none) via host-initiated training sequence. This also selects the speed for the data for originate calls. The modem automatically adapts to the caller's speed on answer calls.

The modem matches the host's parity when it returns status messages to the host. During a data connection, however, the modem passes parity through without interpretation or alteration.

NVRAM

NVRAM can save up to two user-customized modem configurations. The AT&Wn command will store the active modem configuration in one of two NVRAM locations as selected by an n of 0 or 1. The AT^&Yn command selects one of the stored modem configurations to be automatically recalled and activated upon a reset or power up. The ATZn command immediately recalls and activates a stored configuration. See Tables 2 and 3 for storable S-Registers and Commands.

The NVRAM can save up to four telephone numbers, with up to 36 digits or modifiers in each telephone number. The AT&Zn=s command will store s, the telephone number dial string. The ATS=n command will cause the modem to dial one of the four stored telephone numbers. The NVRAM storage location for the four telephone numbers is selected by an n of 0, 1, 2, or 3.

The NVRAM is not available on the CH1786LC.

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Power Supply

The modem module is a complex sub-system that may be treated as any other component. Special attention should be paid to the power supply connections. The modem decodes analog signals from the telephone line that are in the millivolt range and even though the modem is designed to withstand significant induced power supply noise, there is a limit. Steps must be taken to guarantee that power supply noise on all supply lines, including ground, does not exceed 50 mV peak to peak. Any frequency between 20 kHz and 150 kHz must be less than 500 microvolt peak. If necessary, use dedicated power and ground planes. Failure to provide such operating conditions could cause the modem to malfunction.

The Ch1786 requires a single +5V±5% supply. It is recommended that by-pass capacitors be placed on the power supply as close to the modems supply input as practical. It is recommended that a 100 μF Electrolytic capacitor in parallel with a 0.01μF ceramic capacitor be used

VOICE/TONE INJECTION PORT

The CH1786 provides two pins to allow the user to share the telephone line interface associated with the modem for voice and DTMF applications. Figure 3 of the application diagrams shows the configuration for voice/tone utilization.

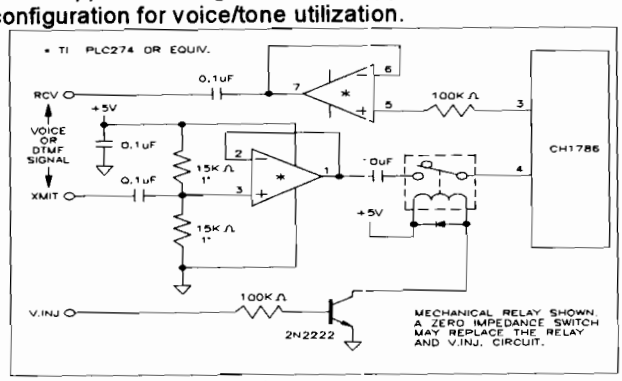

Figure 3. Voice/Tone Injection

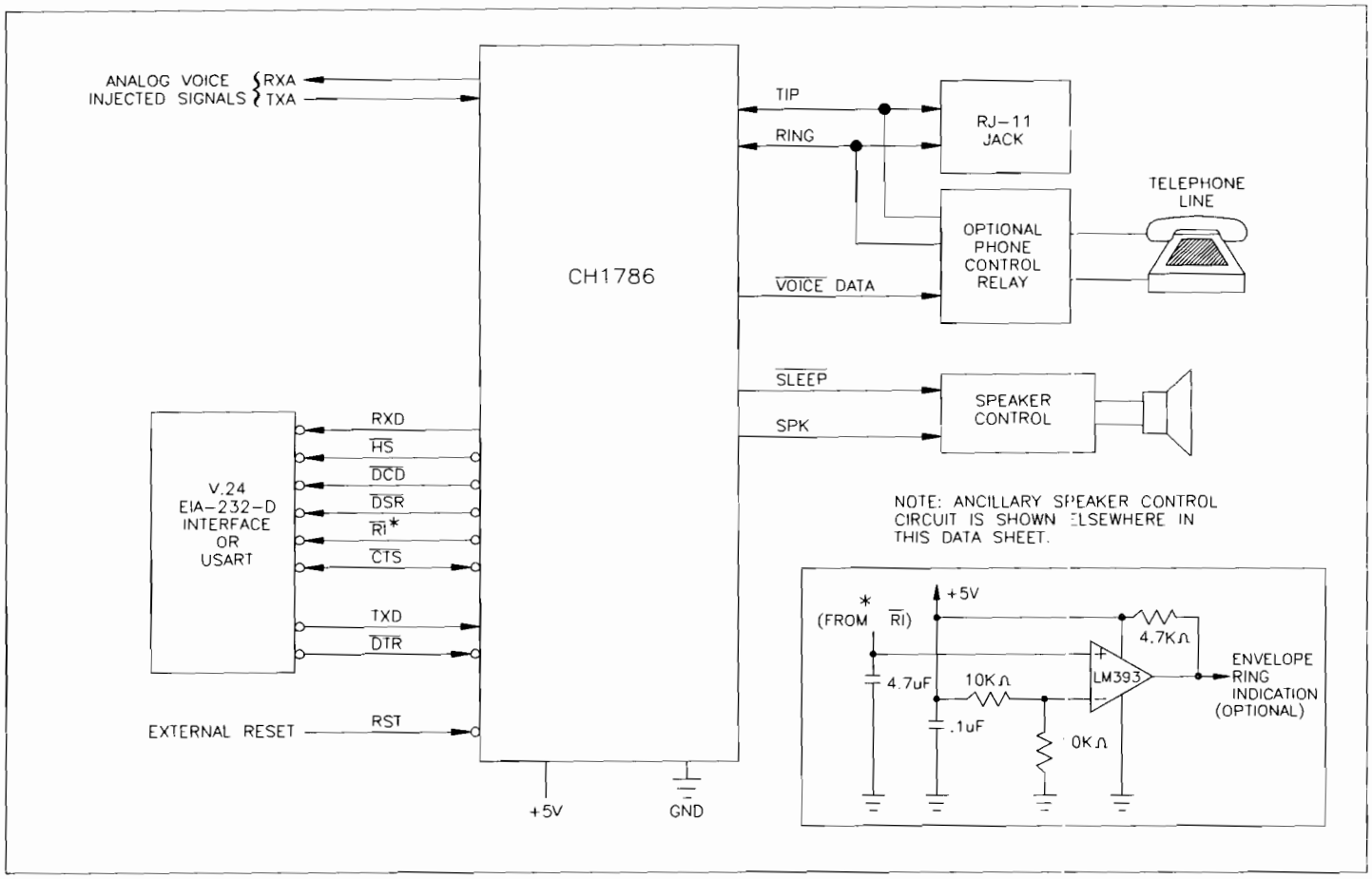

Figure 4 CH1786 Application Diagram

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Typically, voice communication would precede dat communications;in which case, the following commands should be used to configure the CH1786:

ATS0=0 [CR]
ATS7=255 [CR]
ATS10=255 {CR]

1. To answer a voice call
   (a) ATH1 [CR]
   (b) Drive V. INJ. high to activate relay.
   (c) Begin voice conversation.
2. To switch to data mode, drive V.INJ. Low, then:
   (a) At the Originate modem:
   ATX1 [CR]
   (b) At the Answer modem:
   ATA [CR]
3. To disconnect (hang-up) a voice call or a data call:
   ATH [CR]
4. To place a voice call using CH1786's DTMF:
   (a) ATDT#;C0 [CR]
   (b) Drive V.INJ. High

WARNING: The CH1786 has been FCCPart 68 approved as a data modem. Utilization of the Voice/Tone Port requires furthe registration. FCC will require that the system, including the CH1786 and the handset or DTMF transceiver, adhere to Part 68 rules.

MODEM CONTROL

The CH1786 modem may be controlled by sending serial ASCI command sequences. The commands are sent to the mode serially on TXD. After execution of the command, the mode returns a serial status message on RXD, to indicate the completion status of the command.

Initializing the Modem

Before commands may be sent to the modem, the modem must be initialized. This consists of two events: 1) after power-upa hardware reset pulse must be applied to the modem, and 2) eh modem must be trained to the host's speed (2400, 1200, 300 bps) and parity (odd, even, mark, space or none).

Power-up Reset

After applying power to the modem, an internally generated rese pulse iscreated. The user can also reset the modem externally by applying the high-going reset pulse to RST for at least 10ms afte the =5Vpower supply has stabilized. Delay sending commands to CH1786 for 100-200ms.

Training the Modem

The modem must be trained to matchthe host's speed and parity so that it is able torecognize serial asynchronous commands sent to it by the host UART. The host must retrain the modem each time reset signal is applied on RST or after a RESET serial command The modem is trained by sending it the following three characte sequence. (Note: There should be a 50-100 ms intercharacte delay between all command characters. Not required for data.)

AT[CR]
where: **A** and **T** must be upper case or lower case
[CR] represents carriage return
The modem will respondwith one of the following status messages, depending on whether it is optioned for abbreviated or Englis status messages.

CR]	(Abbreviated form)
[CR][LF][OK][CR][LF]	(English form)

where: **[CR]** represents carriage return (ASCII 13)
[LF] represents line feed (ASCII 10)
The modem may be retrained any time while it is idle.

Another attention sequence "A/" is much like the "AT" sequenc except it repeats thepreviously entered command specified with a

"AT" prefix. When given, it must a so be inupper case ASCII. No carriage return is needed.

The Command Format

Typical commands consist of three elements, the attentio sequence, the commands themselves and a terminating carriag return.

AT[commands][CR]
where: [CR] represents carriage return (ASCII 13)

When entering commands tothe modem, the backspace character control-H (ASCII 8)-can be used to edtmistakes. "AT" and "A/" may not be edited however. Multiple commands may be placed inth commandline. A command line may be as long as 40 character excluding AT. The command below instructs the modemot configure itself to not echo characters in the command mode (E and then go to answer mode.

ATE0A[CR]

AT Command Data Rate

With the serial interface, the rate is speed sensed for parity an format.

AT Command Set

The commands are divided into three types; basic commands, di modifiers and ampersand commands as listed in Table 2.

The Status Messages

The modem responds with a status message after each commar is executed. This status message may either be a single dig followed bya carriage return or it may be a carriage return and lin feed with a message in English followed by a carriage return an line feed.

The basic status code subsets are enabled with the Xn comman Where n=0,1,2,3,4 the status codes can be in message formc result codes selected for the five Xn commands.
X0 - Result Codes 0, 1, 2, 3, 4
X1 - Result Codes 0, 1, 2, 3, 4, 5, 10
X2 - Result Codes 0, 1, 2, 3, 4, 5, 6, 10
X3 - Result Codes 0, 1, 2, 3, 4, 5, 7, 10
X4 - Result Codes 0, 1, 2, 3, 4, 5, 6, 7, 10 (factory default)

Result Codes or Status Messages	**Meaning**
0 or OK	Command executed
1 or Connect	Carrier detected at 300 bps
2 or Ring	Ring detected
3 or No Carrier	Did not detect carrier
4 or Error	Entry error
5 or Connect 1200	Carrier detected at 1200 bps
6 or No Dial Tone	Off-hook, but no response after 5 seconds
7 or busy	Busy signal detected
10 or Connect 2400	Carrier detected at 2400 bps

Table 1. CH1786 Pin Descriptions

PIN	NAME	I/0	FUNCTION
1	RING	I/O	Directly connects to the telephone line's Ring lead through a user supplied RJ-11C jack.
2	TIP	I/O	Directly connects to the telephone line's Tip lead through a user supplied RJ-11C jack.
3	RXA	O	**ANALOG VOICE INJECTED.** Receive signal. Let float if not used.
4	TXA	I	**ANALOG VOICE INJECTED.** Transmit signal. Let float if not used.
5	SPK	O	**SPEAKER.** Audio output for speaker. See speaker control diagram.
6	NC	-	No Connection.
7	NC	-	No Connection.
8	$\overline{\text{SLEEP}}$	O	**SLEEP** output. A LOW indicates modem is in low power idle mode. Used to control power to other devices. See Figure 5.
9	NC	-	No Connection.
10	TXD	I	**TRANSMIT DATA.** Serial transmit data input. Marking, or a binary 1 condition, is transmitted when a HIGH is asserted.
11	RXD	O	**RECEIVE DATA.** Serial receive data output. Received MARKING or a binary 1 condition is indicated by a HIGH.
12	$\overline{\text{V/D}}$	O	**VOICE/DATA** output. Used to control a switch between modem and attached phone. See Figure 2.
13	$\overline{\text{DTR}}$	I	**DATA TERMINAL READY** input. Active Low. Switching off DTR can either return modem to command state, disconnect phone call, or reset modem. DTR should be set LOW when not used.
14	$\overline{\text{DSR}}$	O	**DATA SET READY** output. LOW indicates handshaking with a remote modem is in progress, or the data carrier of a remote modem is detected.
15	$\overline{\text{RI}}$	O	**RING INDICATION:** A LOW indicates that the local telephone line is ringing. This signal follows the frequency of the ringing signal (normally about 20 or 30 Hz for 2 seconds).
16	$\overline{\text{CTS}}$	O	**CLEAR-TO SEND** output. Always LOW. Reserved for flow control with fax option. Only active on CH1786FX.
17	$\overline{\text{DCD}}$	O	**DATA CARRIER DETECT** output. LOW indicates a data carrier from a remote modem is detected.
18	$\overline{\text{HS}}$	O	**SPEED INDICATION.** High speed select output. A low on this pin indicates the modem is operating at 2400 bps.
19	VCC	-	5 Volts $\pm$ 5% Note: Noises should be less than 50MV.
20	GND	-	**GROUND.**
21	RST[1]	I	**RESET** input (active HIGH). This input must be asserted HIGH for at least 10 ms to reset the modem. RESET is then returned LOW for normal operation. If no system reset is available, let this pin float to enable internal reset.
22	NC	-	No Connection.

Note: (1) If VCC has a slow power up ramp time, the internal reset may be ineffective.

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Table 2. Register	CH1786 Register Summary Function
S0*	Ring to Answer On
S1	Ring Count
2	Escape Code Character
S3	Carriage Return Character
S4	Line Feed Character
S5	Back Space Character
S6	Wait For Dial Tone
S7	Wait Time for Data Carrier
S8	Pause Time for Comma
S9	Carrier Detect Response Time
S10	Lost Carrier to Hang-up Delay
S11	DTMF Dialing Speed
S12	Escape Code Guard Time
S14*	Bit Mapped Options Register
S16	Modem Test Options
S18*	Test Timer
S21*	Bit Mapped Options Register
S22*	Bit Mapped Options Register
S23*	Bit Mapped Options Register
S24	Sleep Mode Inactivity Time
S25*	Delay to DTR
S27*	Bit Mapped Options Register
S28*	Bit Mapped Options Register

* = S-Registers stored in NVRAM upon receipt of &W command

Table 1-3. Fax Command Set Summary	
Fax Command	**Function**
+CLASS=n	Select Service Class
+F<command>?	Report Active Configuration
+F<command>=?	Report Operating Capabilities
+FAA=n	Data/Fax Auto Answer
+FF	Enhanced Flow Control
+FTS=n	Stop Transmission and Wait
+FRS=n	Receive Silence
+FTM=n	Transmit Data
+FRM=n	Receive Data
+FTH=n	Transmit Data with HDLC Framing
+FRH=n	Receive Data with HDLC Framing
+FRTn	Receive Test Data
+FTTn=m	Transmit Test Data
+Hn	Rockwell Protocol Interface (RPI) Enable

Modem States

The modem can be in either a command state or a data mode state. When the modem is idle, it is in the command state. When a data call is in progress it is in the data mode state. The mode does not recognize commands when in the data state. To recognize commands, the computer must send an "escape sequence" to the modem that forces it out of the data mode and into the command mode.

The escape sequence consists of a "guard time" (a period where no characters are sent to the modem) followed by 3 escape characters followed by a "guard time" again. At powerup, the guard time is set to 1 second minimum and the escape character is set as "+". These two parameters can be modified via registers S2 and S12.

The modem will stay off-hook with its carrier on after the escape sequence is received. It returns an OK status message when it is ready to accept commands. You may re-enter the data mode by issuing the ONLINE command ATO[enter].

Table 3. Basic Commands	CH1786 "AT" Command Set Summary Function
AT	Attention Code
A	Answer Command
A/	Repeat Last Command
*Bn	Communications Standard Option
C	Squelch Transmitter
D	Dial Command
*En	Off-line Character Echo Option
Hn	Switch Hook Control Option
*Ln	Speaker Volume Option
*Mn	Speaker Control Option
On	On-line Command
P	Pulse Dial
*Qn	Result Code Display Option
Sn	Select an S Register
Sn=	Write to an S Register
Sn?	Read an S Register
*Vn	Result Code Form Option
*Xn	Result Code Set/Call Progress Option
+++	Escape Code Sequence
,	Pause
?	Returns Last Addressed S Register
*Yn	Long Space Disconnect Option
Fn	On Line Echo Character Option
Z	Reset
Dial Modifiers	**Function**
P	Pulse Dial
R	Originate Call in Answer Mode
T	Touch Tone Dial
W	Wait for Dial Tone
;	Return to Idle State
@	Wait for Quiet Answer Command
!	Flash Hook
,	Pause
0-9	Dial Digits/Characters
A,B,C,D	
Ampersand Commands	**Function**
* &Cn	Data Carrier Detect Option
* &Dn	Data Terminal Ready Option
&F	Load Factory Defaults
* &Gn	Guard Tone Option
* &Pn	Make to Break Ratio Selection
* &Sn	Data Set Ready Option
&Tn	Test Command Option
&V	View Active Configuration
* &Wn	Store active profile
* &Yn	Recall active profile
* &Zn	Store telephone numbers
Percent Commands	**Function**
%Dn	DTMF Attenuation
%J	Load Secondary Factory Defaults

Note: A detailed definition of all commands and registers is available from Cermetek Microelectronics, Inc.
* = Commands that can be stored in NVRAM.
Not supported by the CH1786LC.

"AT" COMMAND APPLICATIONS

Pause ","

When placing a call from an office with a telephone connected to a PBX, it may be necessary to dial an access code (usually the digit 9) to get an outside line. Inserting a comma in the telephone number commands the modem to pause for a specific length of time. The factory default pause time is 2 seconds.

Example: Dial 9, pause, dial number.

Enter: AT DT9, 1234567

Multiple commas may be used for a greater delay time.

Touch Tone And Pulse Dialing "T and P"

The modem can use DTMF (touch-tones) or dial pulses when dialing a telephone number. If the dial command does not specify which type to use, the modem defaults to the type last specified. The power-on default value is P.

Example: Pulse dial 9, pause, touch-tone dial number.

Enter: AT DP9, T1234567

Originate a Call in Answer Mode "R"

The D command forces the modem into originate mode. To call an originate-only modem, dial the number and set the modem to answer mode via the R (reverse originate). Enter the R command at the end of the telephone number.

Example: Dial number in answer mode.

Enter: AT D1234567R

Redial Last Number "A/"

Use A/, the repeat command, to redial the last telephone number dialed when a busy signal is received.

Return to Command State";"

The modem can be forced to reenter the command state after dialing (without hanging up) by ending the dial command with a semicolon. This is useful when using the modem as an auto dialer.

Example: Touch-tone dial 9, pause, dial number, return to command.

Enter: AT DT9, 1234567;

Result: OK

Automatic Answering

The S0 register controls the number of rings that must occur before the modem answers a call. The register may range in value form 0-255.

S0=0	DO NOT ANSWER TELEPHONE
S0=1	ANSWER ON RING 1
S0=2	ANSWER ON RING 2
S0=3	ANSWER ON RING 3

SO=255 ANSWER ON RING 255

When S0 is set to 0, the modem will not auto-answer.

Example: Assign the value "6" to S0 to set the modem to answer on the sixth ring.

Enter: AT S0=6

Result: OK

Dial a Number "D"

The Dial command takes the form Dn, where n is a string of characters. In the simplest form, n will be only the digits of the phone number to be dialed.

Example: Dial number.

Enter: AT D1234567

In response to this command, the modem dials the telephone number "123-4567" and then waits for carrier from a distant modem. If no carrier is detected within a given time (the default time is 30 seconds), the modem automatically releases the line and sends a NO CARRIER result code. If carrier is detected, the modem gives a CONNECT result code and goes on-line, permitting communication with the distant modem.

The Dial Command may also be issued without a telephone number. ATD causes the modem to pick up the telephone line without dialing a number.

Connecting to the Host UART

Since a modem communicates data serially and most host products handle data in a parallel format, a UART is needed to make parallel-to-serial and serial-to-parallel translations.

The Serial Interface Lines

the module supports a full RS-232C/V.24 serial interface. Signal levels are TTL rather than RS-232C level compatible, which allows you to directly connect the modem to your host's UART without level translating circuitry. A complete description of each signal follows under Pin Description.

Three of these lines must be utilized for proper modem operation: TXD, RXD and DTR. The modem is controlled by sending it serial commands over TXD and can be monitored by serial status messages returned on RXD. DTR must be asserted ON (LOW) for the modem to interpret commands sent to it on TXD and will disconnect a call id DTR is asserted OFF (HIGH) during a call.

All other serial interface lines may be utilized for the convenience of your application but are not required by the modem. Unused outputs (from modem) should be left unconnected. Unused inputs should be tied to the proper logic level.

Fax Modes (CH1786FX only)

The CH1786FX supports Send and Receive Fax in addition to the modem functions as defined by CH1786.

Fax modes and rates are determined by the AT=F commands.

Fax modem processing is explicitly defined in CCITT V.29, CCITT V.27 ter, and CCITT V.21 recommendations. All modulation waveform spectrum and data processing functions conform to the appropriate specifications.

For additional information on CCITT recommendations, contact Omnicom, Tel: 703-281-1135 or see Rockwell's RC224AFT Designer's Guide, Tel: 714-221-4600.

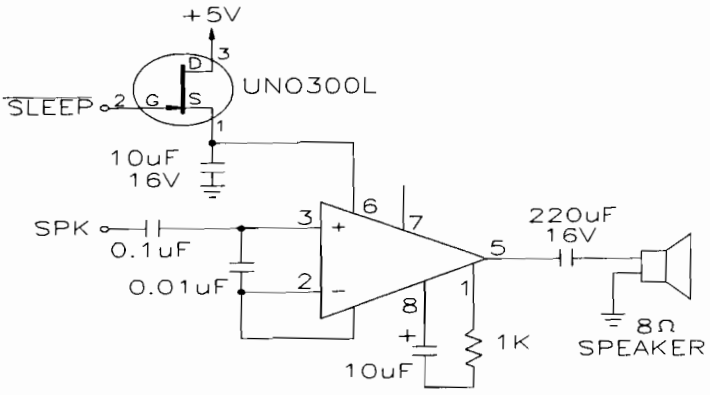


Figure 5. Speaker Control Circuit - optional to allow for call progress monitoring.

Phone Line Connection Guidelines

1) The mounting of the CH1786 in the final assembly must be made so that it is isolated from exposure to any hazardous voltages within the assembly. Adequate separation and restraint of cables and cords must be provided.

2) The circuitry from the CH1786 to the telephone line interface must be provided in wiring that carries no other circuitry than that specifically allowed in the rules (such as A and A1 leads).

3) Connection to the phone line should be made through an RJ-11 jack.

4) Traces from the modem's RING and TIP pins to the RJ-11 jack must exceed 0.1 inch spacing to one another and 0.2 inch spacing to all other traces. The traces should have a nominal width of 0.02 inches or greater.

5) The RING and TIP traces should be as short as possible and oriented to prevent coupling other high speed or high frequency signals onto the host circuit card.

6) No additional circuitry other than that shown in the following Figure may be connected between the modem module and the RJ-11 jack.

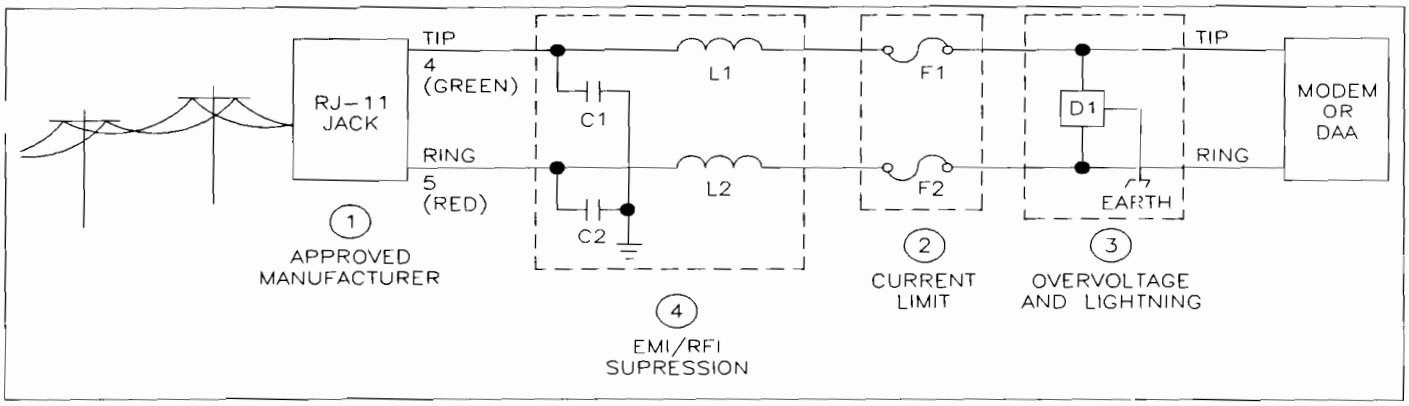
7) The CH1786, the RJ-11 jack and the interfacing circuitry and traces in between, must be mounted on a circuit board with a 94 V-0 flammability rating.

8) The supplied FCC registration label must be applied visibly on the outside of the host product.

9) the host product's User Manual must provide the user with instructions for connection and use as recommended in Section FCC Registration.

International Approvals

The CH1786 can additionally be approved for some international telephone connections. This must be done, however, after the modem is installed in the host product. The entire host product must then be submitted to the international country's Telephone Network for approval.



1) Manufacturers list - see FCC Public Notice #42269, dated 3/23/94. RJ11 Jacks, must be provided by one of the vendors on this list.
2) Current Line Device: F1 and F2 - 1.25 amp
   A. UL 1459 must use a current limit device. A Raychem Poly Fuse TR 600-150 is recommended as this device resets automatically after each power cross. Acceptable devices are fuses from Little Fuse, type 25101.5 or Cooper Ind. Bussman, type MCR 1 ½.
   B. Resistors (10 ohm carbon film or SMD 1/8 w min) can be used for non UL applications.
3) Over Voltage and Lightning Protection
   A. The Device is provided with an internal sidactor device that protects from metallic voltage surges.
   B. DOC (Canada) May require current limit devices external to the module. Use 1ohm resistors (carbon film or SMD parts 1/8 w min) in each lead (Tip and Ring). You may also substitute fuses or the PolyFuse described in Section 2.
   C. For lightning prone areas where there are more than 2 storms per year. Provide an earth ground connection and the following part, (this is FCC or DOC acceptable). Teccor Sidactors P3203AB or P3100BA70. These devices give metallic and longitudinal protection for the modem. This must also include the current protection of Section 2.
4) EMI/RFI Suppression
   The capacitor/inductor network should be located as close to the RJ11 Jack as possible with excellent ground path to the chassis. Capacitors C1 and C2 should not exceed .005 mF. They must have a rating of 1.5 KV and typically are on .001 +/- 20%. Inductors L1 and L2 are Fair-Rite 2643666611 or 2943666661. These are ferrite cylinders and provide attenuation to high frequencies from system level components beyond the modem. These values are to be adjusted per the product design.

Figure 6 Telephone Line Interface

MOUNTING THE MODEM

The modem contains static sensitive devices and should only be handled by personnel and in areas that are properly protected against static discharge.

There are two popular mounting techniques that are recommended for physically connecting the modem to your circuit card; 1) sockets, and 2) direct soldering. Each approach has its own set of benefits and challenges.

If the modem is wave soldered on a circuit card, flux and other corrosive chemicals can be left inside the modem's plastic housing. Care should be taken during the freon rinse cycle to fully wash the chemical residue away. Ideally, the modem should be soldered in by hand after the rest of the card is wave soldered to minimize this problem. Also, soldering can present a sizable challenge if the modem ever needs to be removed from the card.

The socketing approach to mounting eliminates cleaning and desoldering concerns. When socket is used, it must make a solid connection to all modem pins. Failure to do so will cause unreliable modem operation. Also, steps should be taken to assure that the module remains tightly seated in the socket after the host product is shipped.

FCC REGISTRATION

The CH1786 is registered with the FCC (Federal Communications Commission) under Part 68. To maintain the validity of the registration, you must serve notice to the end user of the product that contains the modem of several restrictions the FCC places on the modem and its use. The following notice is recommended and should be included in the host product's USER MANUAL. Also, the FCC requires that Cermetek make all repairs to the modem. If repair is necessary after the modem is installed in your product and has been delivered to your customer, the modem must be returned to you where it can be removed from he host product and the forwarded to Cermetek for repair.

Changes in Attestation Procedure for Plugs and Jacks

(Name of applicant) attests that the network interface plugs or jacks used on this equipment comply with and will continue to comply with the mechanical requirements specified in Part 68, Sub-part, F specifically the dimensions, tolerances and metallic plating requirements. The compliance of these connectors will be assured by purchase specifications and incoming inspection. Documentation of such specifications and/or inspections will be provided the FCC within 30 days of their request for same.

FOR YOUR USER'S MANUAL

The Part 68 rules require the following or the equivalent information be provided to the end user of equipment containing a DAA:

Type of Service: The _insert your product name) is designed to be used on standard device telephone lines. It connects to the telephone line by means of a standard jack called the USOC RJ 11C (or USOC FJ45S). Connection to telephone company provided coin service (central office implemented systems) is prohibited. Connection to party lines service is subject to state tariffs.

Telephone Company Procedures: The goal of the telephone company of to provide you with the best service it can. In order to do this, it may occasionally be necessary for them to make changes in their equipment, operations or procedures. If these changes might affect your service or the operation of your equipment, the telephone company will give you notice, in writing, to allow you to make any changes necessary to maintain uninterrupted service.

In certain circumstances, it may be necessary for the telephone company to request information from you concerning the equipment which you have connected to your telephone line. Upon request of the telephone company, provide the FCC registration number and the ringer equivalence number (REN); both of these items are listed on the equipment label. The sum of II of the REN's on your telephone lines should be less than five in order to assure proper service from the telephone company. In some cases, a sum of five may not be useable on a given line.

If Problems Arise: If any of your telephone equipment is not operating properly, you should immediately remove it from your telephone line, as it may cause harm to the telephone network. If the telephone company notes a problem, they may temporarily discontinue service. When practical, they will notify you in advance of this disconnection. If advance notice is not feasible, you will be notified as soon as possible. When you are notified, you will be given the opportunity to correct the problem and informed of your right to file a complaint with the FCC. Contact your telephone company if you have any questions about your phone line.

In the event repairs are ever needed on the (insert your product name), they should be performed by (insert your company name) or an authorized representative of (insert your company name). For information contact: (insert your company address).

DEFAULT STATUS, PERFORMANCE AND SPECS

Default Configuration Profile
Async mode selected
2400 bps
Bell 212A operation at 1200 bps
Even parity
Auto answer enabled (Disabled on CH1786LC)
Command echo ON
All result codes enabled - extended
Wait for dial tone before dialing - 2 seconds
Detects busy signal
Full word result codes
Pulse dial make/break ratio = 39/61
DSR enabled
Modem enabled DTR (Disabled on CH1786LC)
DCD enabled (Disabled on CH1786LC)
Speaker enabled but off when receiving carrier
Speaker volume set to medium
Local modem will grant RDL request from remote modem
Guard tones disabled
Minimum DTR pulse width = 0.1 seconds
Ring count - 01 (CH1786)
Escape code character = 43
Carriage return character = 13
Line feed character = 10
Back space character = 08
Duration of wait for dial tone = 02 seconds
Duration of wait for carrier after dialing = 30 seconds
Duration of dial pulse (comma) = 02 seconds
Carrier detect response time = 0.1 seconds
Escape code guard time = 1 second
Length of use after comma = 2.0 seconds
Last carrier to hang up delay = 0.1 seconds
DTMF interdigit delay = 0.1 seconds
DTMF Attenuation = -4dB
Sleep mode inactivity time = 5 seconds
Long space disconnect disabled

Table 4. CH1786 System Data Mode Compatibility Specifications

Parameter	Specification
Asynchronous Speed Range	2400, 1200, 600bps, character asynchronous. 0-300 bps asynchronous
Asynchronous Format	TxD may differ = 1%, -25% from modem output. Offsets will be corrected by adding/deleting stop bits.
Telephone Line Interface	8, 9, 10 bits, including start, stop, parity
Modulation	V.22 bis, 16 point QAM at 600 baud. V.22 and 212A, 4 point DPSK at 600 baud. 103 binary phase coherent FSK.
Self Test Pattern Generator	Alternate 'ones' and 'zeros' and error detector, to be used long with most loopbacks. A number indicating the bit errors detected is sent to DTE.
Transmit Carrier Frequencies V.22 bis V.22, 212A Bell 103 mode	Originate 1200Hz ±.01% Answer 2400Hz ±.01% Originate 'space' 1070Hz ±.01% Originate 'mark' 1270Hz ±.01% Answer 'space' 2025Hz ±.01% Answer 'mark' 2225Hz ±.01%

Parameter	Specification
Receive Carrier Frequencies V.22 bis, V.22, 212A Bell 103	Originate 2400Hz ±7Hz Answer 1200Hz ±7Hz Answer 'space' 2025Hz ±7Hz Answer 'mark' 2225Hz ±7Hz Originate 'space' 1070Hz ±7Hz Originate 'mark' 1270Hz ±7Hz
Receiver Sensitivity	OFF to ON threshold--43 dBm ON to OFF threshold--48 dBm
Hysterisis	2 dB minimum
Line Equalization	Fixed compromise equalization, transmit. Adaptive equalizer for PSK/QAM, receive
Diagnostics Available	Local analog loopback. Local digital loopback. Remote digital loopback. Request remote digital loopback. Local interface loopback modem with self test.
Call Progress Tones Detected:	With speaker or quiet screen messages (no dial tone, busy, ring-back, modem answer tone and voice.)
Computer Interface:	IBM PC/XT/AT bus compatible with an 8250/16450/16550A UART as a serial controller.

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Table 5.
CH1786 Electrical Specifications

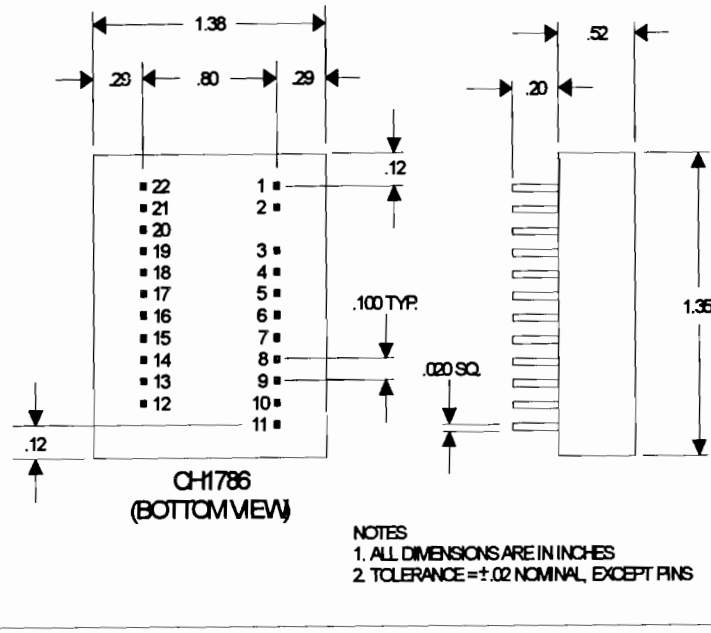
Parameter	Description	Min.	Typ.	Max.	Units
V_{CC}	Positive Supply Voltage - Noise less than 50MV	4.75	5.0	5.25	V
I_{CC} off Hook I_{CC} on Hook	Nominal Operating Current when modem is OFF Hook		50	75	mA
	Nominal Operating Current when modem is ON Hook		25	50	mA
I_{CCPD}	Power Down Current			10	mA
V_{IH}	High Level Input Voltage	2			V
V_{IL}	Low Level Input Voltage	-0.3		0.8	V
VT+	Positive Hysterisis Threshold for RESET pin		2.5		V
VT-	Negative Hysterisis Threshold for RESET pin		1.8		V
V_{OH}	High Level Output (I_{OH}=0.5 mA)	2.4			V
V_{OL}	Low Level Output (I_{OL}=1.6 mA)			0.6	V

Table 6
Other Performance Specifications

Parameter	Min.	Typ.	Max.	Units	Comments
Tone 2nd Harmonic Distortion			-35	dB	HYB enabled into 600Ω
DTMF Twist (Balance)		3		dB	
DTMF Tone Duration	50		255	ms	95 ms default
Pulse Dialing Rate		10	20	pps	10 pps default
Pulse Dialing Make/Break		39/61 33/67		% %	US, Canada default UK, Hong Kong
Pulse Interdigit Interval	700		3000	ms	789 ms default
Guard Tone Frequency Amplitude Frequency Amplitude		550 -6 1800 -9		Hz dB Hz dB	referenced to High channel transmit
High Channel Transmit Amplitude		-1		dB	referenced to Low channel, Guard Tone enabled
Guard Tone 2nd Harmonic Distortion		-40		dB	
Call Progress Passband Frequency	120		620	Hz	
Wait Time for Dial Tone	2		255	sec	Two second default
Return loss @ 1000 Hz		30		dB	t_r=600Ω=2.16 μF

Table 7
Temperature Options

Model	Operating Temperature
CH1786	0°C to +70°C
CH1786ET	-40°C to +85°C
CH1786LC	0°C to +55°C



PACKAGE CONNECTION TABLE			
PIN NO.	FUNCTION	PIN NO.	FUNCTION
1	RING	12	NC
2	TIP	13	DTR
3	RXA	14	DSR
4	TXA	15	RI
5	SPK	16	CTS
6	NC	17	DCD
7	NC	18	HS
8	NC	19	VCC
9	NC	20	GND
10	TXD	21	RST
11	RXD	22	RTS

Figure 7. CH1786 Physical Dimensions and Pin Functions.

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